

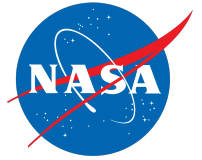
SLAPex Freeze/Thaw Radiometer Data Products

18 July 2017

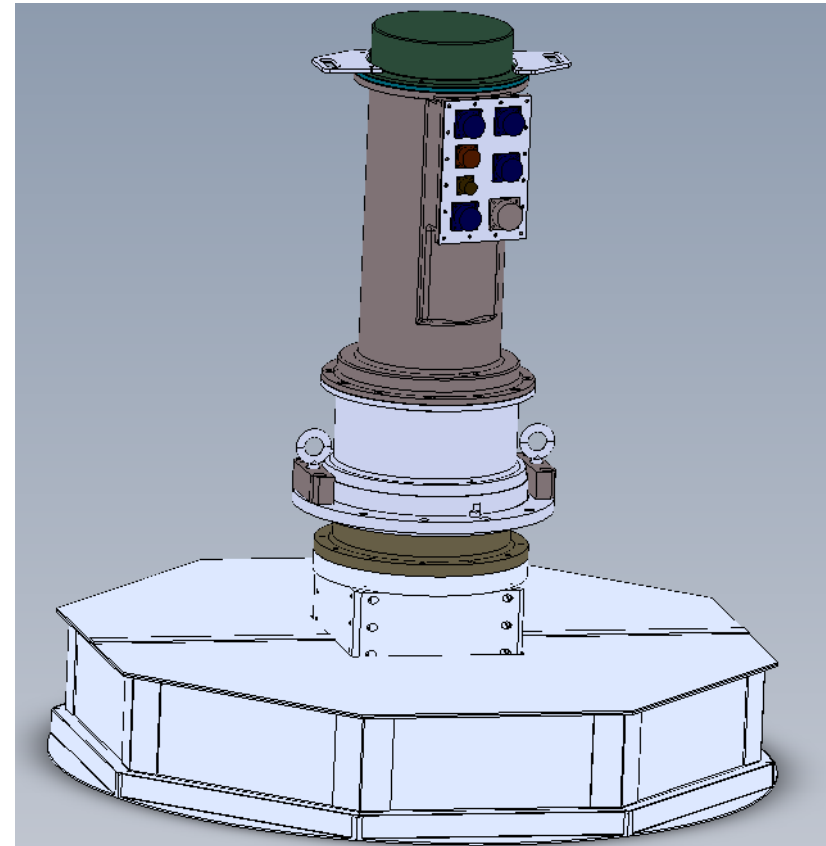
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SLAP Instrument Overview

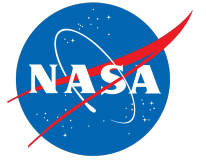


- SLAP consists of two instruments on a rotating platform that protrudes beneath the aircraft
 - Passive microwave radiometer
 - Active microwave scatterometer (radar)
- The two instruments share a dual-frequency dual-polarization antenna configured for 40° conical scan
- Replicates key engineering specifications of the NASA Soil Moisture Active/Passive (SMAP) mission
 - Sensing frequencies
 - Scan geometry
 - Radiometer front-end and internal calibration
 - RF interference processor

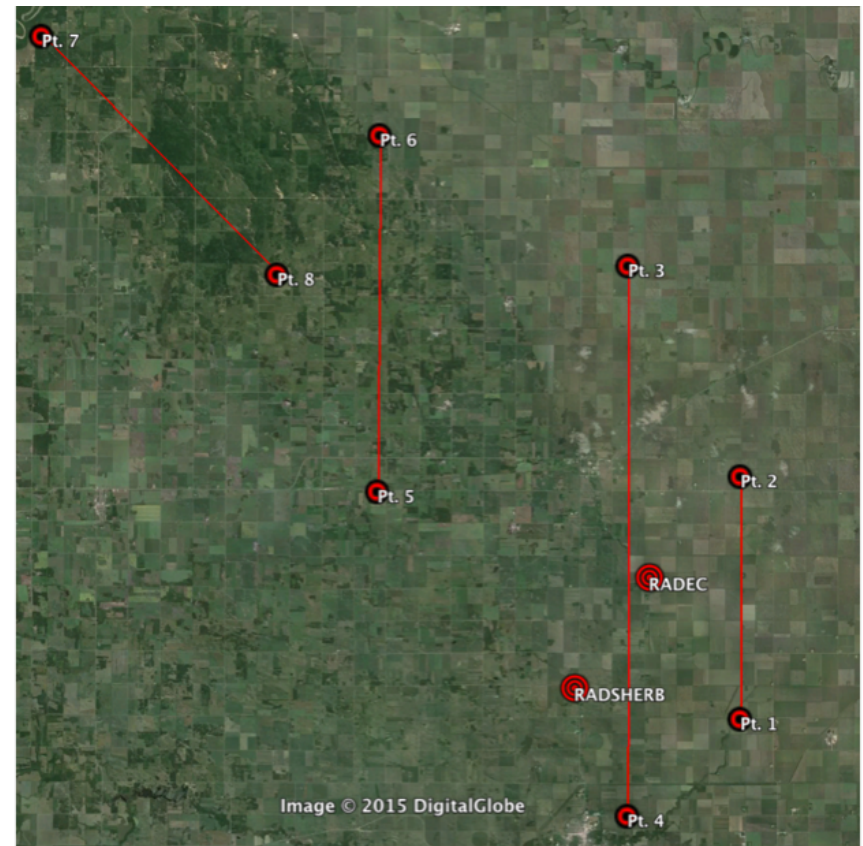




SLAPex Canada

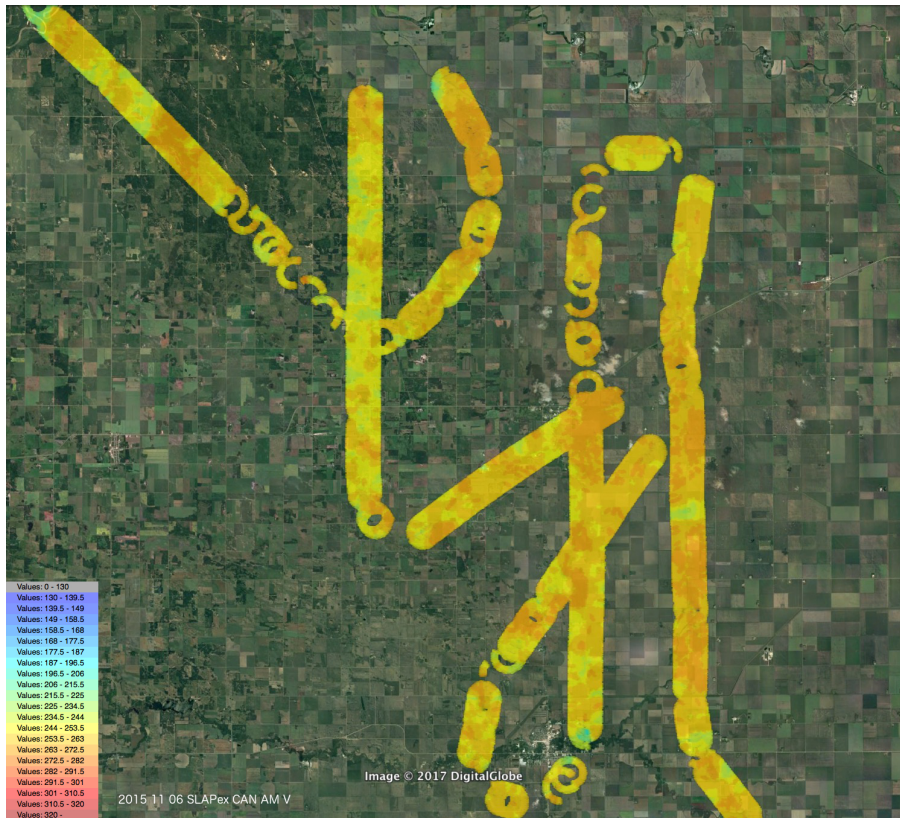
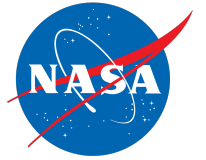


- Five flight lines flown to correspond with ground truth team sample locations
- Flights were flown during frozen soil (AM) and thawed (PM) conditions on five days
- Two additional flights were flown to obtain full coverage of a 36x36 km SMAP pixel, one in thawed and the second in frozen conditions
- A “mow-the-lawn” (MTL) flight pattern was used to obtain maximum coverage

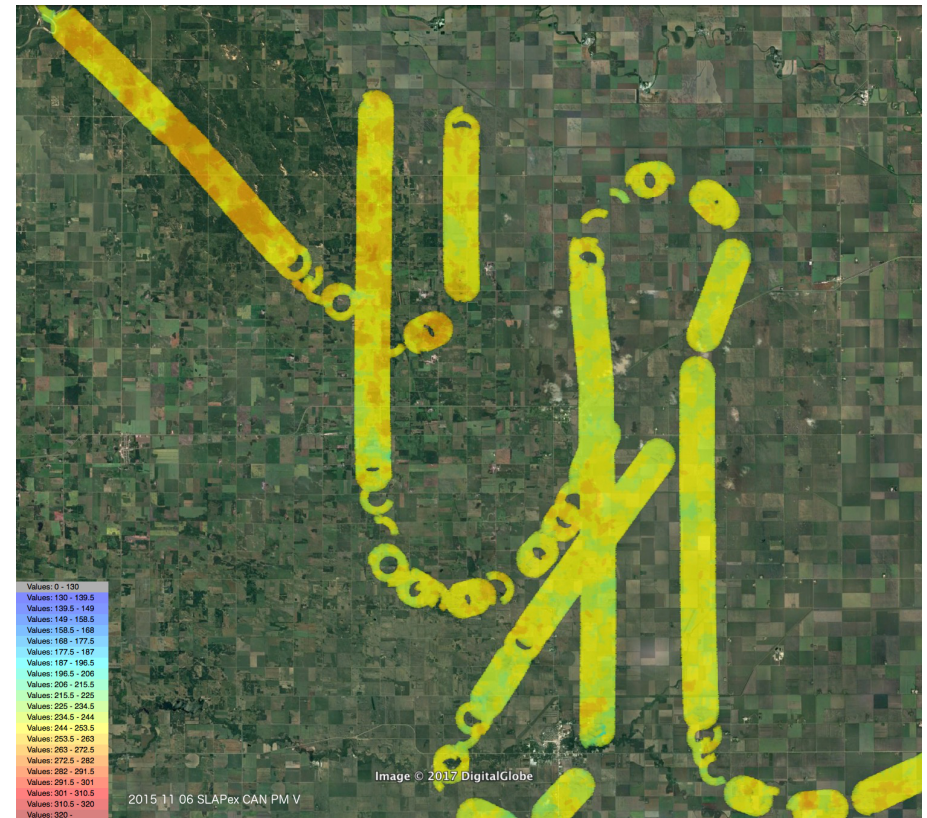




Frozen/Thawed Comparison



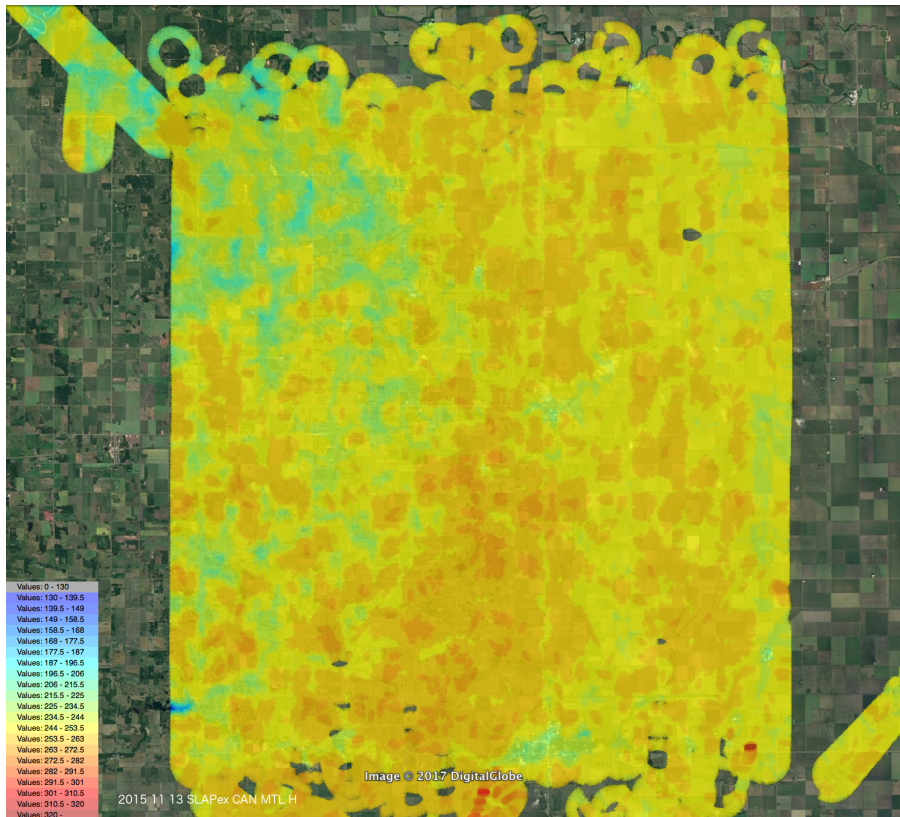
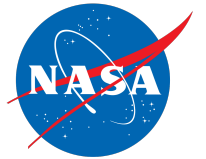
2015-11-06 Frozen V-polarization



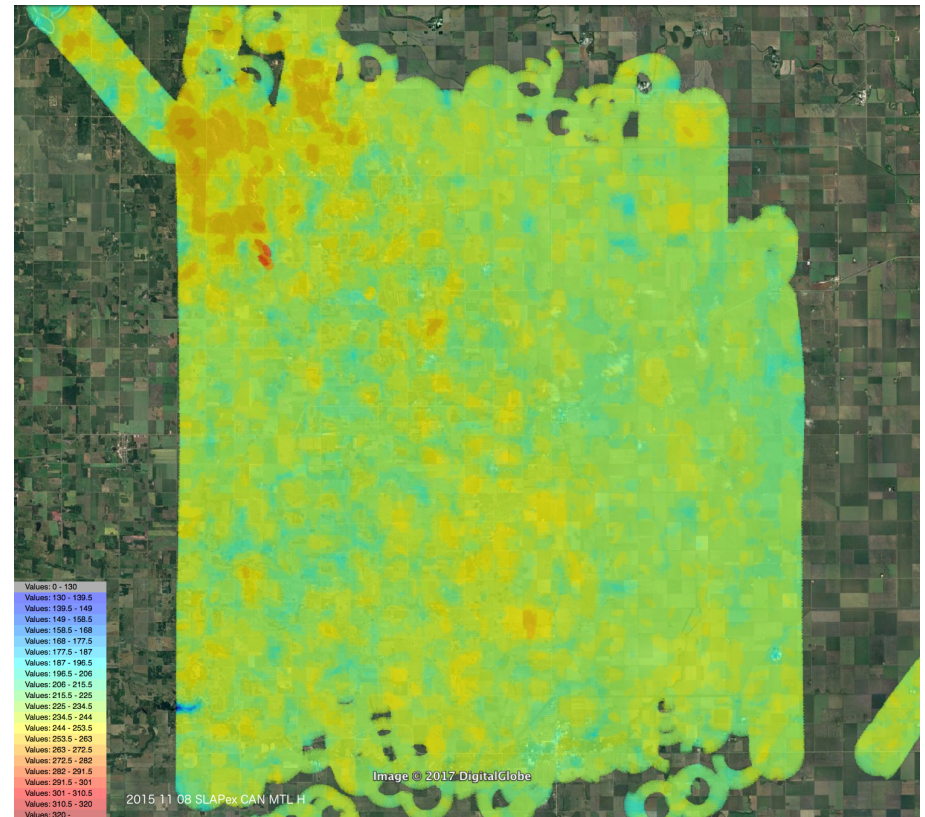
2015-11-06 Thawed V-polarization



Frozen/Thawed Comparison



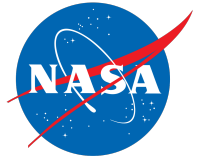
2015-11-13 Frozen H-polarization



2015-11-08 Thawed H-polarization



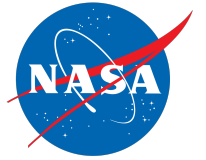
Data Overview



- Data provided is L1 data: geolocated and calibrated to engineering units (kelvins), but not gridded (points are in a time-series)
- Individual data points are actually 2D oval beam “footprints”, dimensions of which are provided in the data file
- Data is provided online in CSV, MATLAB, and Google Earth formats at <https://aesmir.gsfc.nasa.gov/index.php?section=128>
- Fields provided:
 - Timestamp
 - Footprint Latitude (°)
 - Footprint Longitude (°)
 - T_B H-polarization (K)
 - T_B V-polarization (K)
 - Footprint Semi-major Axis (m)
 - Footprint Semi-minor Axis (m)
 - Beam heading (°)
- Accuracy of ± 1 K



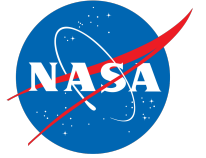
Calibration/Corrections



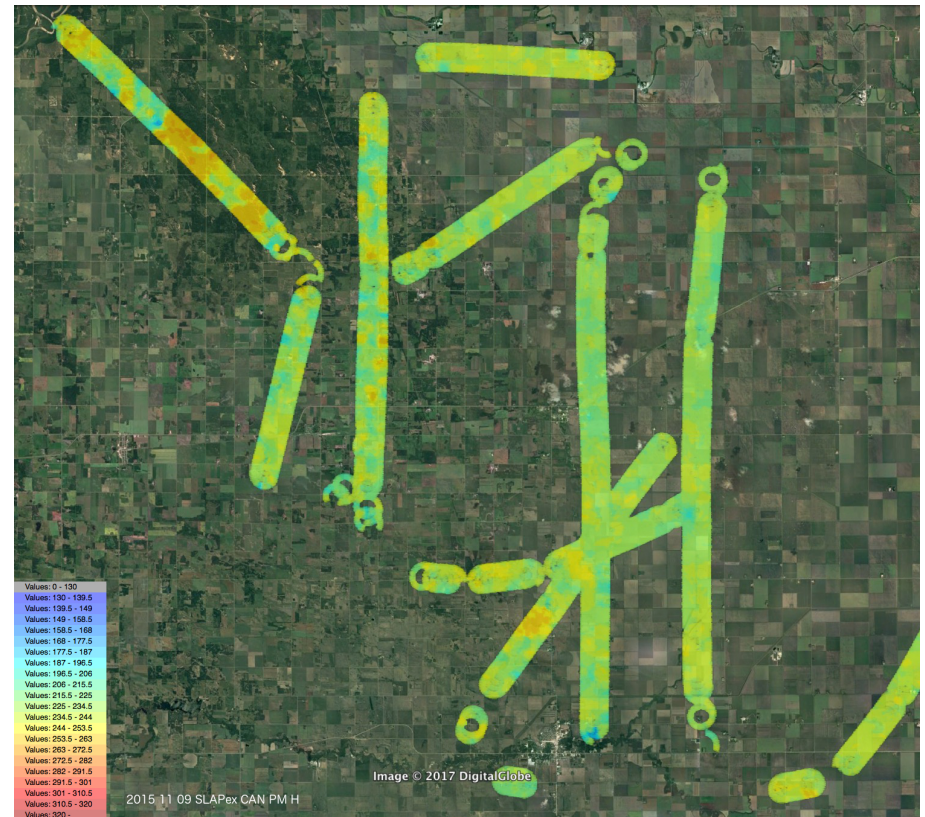
- SLAP radiometer signal is digitized by the SMAP RFI Clone onboard the instrument and saved as raw counts values which must be calibrated
- External two-point calibration was performed after the SLAPex deployment when the instrument was downloaded from the aircraft
- Pre- and post-flight single-point calibration with an anechoic foam target is performed to update the radiometer offset
- The internal references and noise diode stabilize the instrument during flight
- All of these inputs are used to correct and scale the raw M2 counts to produce calibrated engineering units (kelvins)
- Calibration equations and procedures are equivalent to those used by SMAP radiometer
- The SLAP antenna, due to its thin, directional design, has sidelobes in the nadir direction as well as opposite the main beam, leading to a beam efficiency of only 90%
- A first-order antenna pattern correction (APC) was developed and implemented to improve on the beam efficiency
- This correction assumes unwanted energy from the antenna sidelobes originates from a field of uniform dielectric constant and corrects for the extra energy using the measured antenna pattern
- In most real cases this should improve the equivalent beam efficiency to around 98%



Google Earth Files

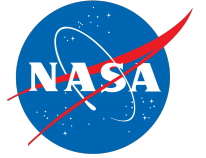


- Google Earth (KMZ) files provide a visual representation of the SLAP data plotted on a map
- Timestamp and T_B value are embedded in each footprint plotted, so each point can be clicked for additional metadata
- **Animation demo!**

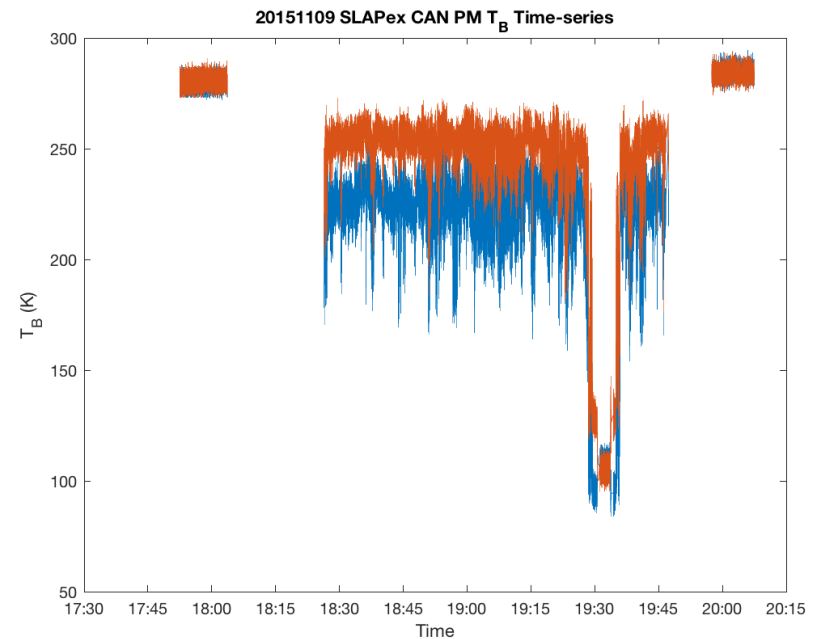




MATLAB and CSV Files

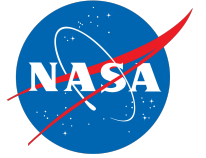


- MATLAB (.mat) and CSV files provide the processed data products in a tabular format for ingest in to your preferred number-crunching software
- Both files are equivalent





Finding Data in MATLAB



```
lat_filter = (footprint_lat >= 49.6211 & footprint_lat <= 49.6283);  
lon_filter = (footprint_lon >= -97.9031 & footprint_lon <= -97.8919);
```

```
time_filter = (timestamp >= datenum('2015-10-30 13:00:00') & ...  
               timestamp <= datenum('2015-10-30 14:00:00'));
```

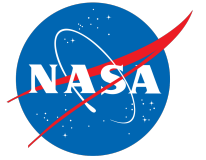
```
filtered_TBh = mean(TBh(time_filter & lat_filter & lon_filter))  
filtered_TBv = mean(TBv(time_filter & lat_filter & lon_filter))
```

```
filtered_TBh =      201.125030653464  
filtered_TBv =      231.658456557318
```

- The above code shows how to isolate data by time, latitude, and longitude
- Using logical indexing in MATLAB creates a boolean vector that can be used to index the full time, latitude, longitude, and T_B vectors
- This method can be used to pinpoint specific fields, grid data, or otherwise make the data more useful for your individual applications



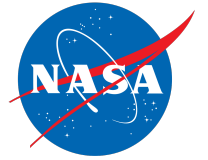
Data Notes



- Scan Geometry
 - As a conical scanning instrument, the SLAP antenna sees brightness temperature at a fixed elevation angle (40°) but from many azimuths
 - Nonhomogeneous surfaces may appear to have different brightness temperatures depending on the azimuth angle
 - Scan data was averaged to provide a footprint every $\sim 6^\circ$, leading to overlap between adjacent footprints
 - Data footprint size corresponds to antenna 3dB beam width – half of the energy comes from outside the drawn footprint
- Roll Filter
 - Aircraft roll was filtered at $\pm 3^\circ$ to remove spurious data collected during non-level flight
 - Remaining data is uncalibrated and not a part of the standard data product
 - This may result in partial scans in the middle of turns



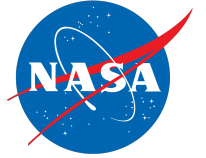
Further Work



- T3/T4
- Scatterometer data
- RFI detection
- Delmarva/Oklahoma Data
- Level 2 products (freeze/thaw, soil moisture)



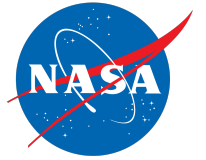
Conclusion



- For SLAPex Canada, Level 1 H- and V-polarization brightness temperature data are available for use
- Data are available for download at <https://aesmir.gsfc.nasa.gov/index.php?section=128>
- Additional data products and results from other campaigns are pending additional time/money



Acknowledgements



- Special thanks to:
 - Pilots and crew from NASA Langley Research Center and NASA Glenn Research Center
 - Ground teams from Agriculture Canada, Environment Canada, University of Guelph, George Mason University, and City University of New York
 - Calibration and antenna pattern corrections by Dr. Derek Hudson and Dr. Cornelis Du Toit in the NASA GSFC Microwave Instruments & Technology Branch and Flight Microwave & Telecommunications Systems Branch

